

Sixty Years of Engagement Between ESO and Chile: Past, Present and Future

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On 6 November 1963 ESO and the Republic of Chile started a journey together that enabled the establishment in Chile of all ESO's observatories and telescopes so far. Despite all the challenges that the world went through over these six decades, a strong partnership between ESO and Chile has been forged. A vibrant user community in Chile has grown and matured, and ESO is proud to have accompanied this remarkable evolution. In this article I look at the past and present of the engagement between ESO and Chile and argue in favour of a future joint path.

How it began

It was very soon after the Convention to establish ESO as an intergovernmental organisation was signed in 1962 that the organisation decided to establish its (first) astronomical observatory in Chile. The signature of the *Agreement between the Government of Chile and the European Organisation for Astronomical Research in the Southern Hemisphere for the establishment of an astronomical observatory in Chile* on 6 November 1963¹ was a hallmark decision that set the scene for the coming decades of both European and Chilean astronomy.

The clear skies of the Atacama Desert were of course a key factor in selecting that option (Blaauw, 1991), but there was a lot more behind the decision: professional Chilean astronomy was beginning a path of growth and development². While the study of the sky from northern Chile probably dates back to very ancient times, the development of professional astronomy in the country finds its roots in the middle of the nineteenth century. The very first astronomy centre in South America was established in Santiago around 1849, with the support of the President of Chile and important academic institutions. The National Astronomical Observatory (OAN) was created in 1852 by a presidential decree and has remained in Santiago since then. Pioneering scien-

tific observations of the southern sky were performed using OAN's telescopes at various sites. In 1927 the OAN became part of the University of Chile, while another very powerful astronomy centre was taking off at the Pontificia Universidad Católica de Chile.

In the 1950s the excellence of the Chilean skies was known around the world, and Chile took the strategic decision to engage with international institutions in establishing their observatories in Chile. The 1963 agreement between ESO and Chile was therefore signed on very flourishing astronomical soil in Chile. The opening of astronomical observatories on La Silla (ESO) and of the Cerro Tololo Inter-American Observatory (CTIO) followed, both in 1969.

The current legal framework within which ESO and Chile cooperate on astronomy matters is also an international agreement: the *Interpretative, Supplementary and Amending Agreement* to the 1963 agreement, signed on 18 April 1995. This agreement led to the establishment of the Paranal Observatory to host the Very Large Telescope (VLT) and VLT Interferometer (VLTI), as well as to other very important elements, including site protection commitments, contributions to the development of Chilean astronomy, the granting of 10% of the observing time at all ESO facilities to meritorious proposals by astronomers from the Chilean community, and inclusion of Chilean astronomers in ESO's scientific advisory bodies.

ESO's observatories in Chile

Under the umbrella of the 1995 treaty, and under very similar principles, site agreements were signed not only for the VLT and VLTI (April 1995) but for the rest of ESO's observatories in Chile: APEX (August 2002), ALMA (October 2002), the Extremely Large Telescope (ELT, October 2011), and the Cherenkov Telescope Array (CTA-South, December 2018).

The reasons why ESO continued to establish all its current observatories in Chile are diverse. The driving criteria for the various site selections have invariably been of a technical nature. The exceptional conditions of the Atacama Desert

for optical and infrared observations (for example, in Paranal weather losses rarely reach 10%, seeing is excellent and the dryness of the air secures a low median precipitable water vapour, critical for infrared observations) have driven the selection of first Paranal and then Armazones. The altitude, dryness and size of the Llano de Chajnantor have identified that site as unique for submillimetre observations.

Next to those criteria, the continued support of the Chilean authorities, in facilitating ESO organisational operations, in granting access and administration of the sites and engaging in their protection as well as in facilitating access to infrastructure, has played an important role, which is acknowledged and appreciated. And not to be overlooked, ESO's accumulated experience of working in Chile, the existing infrastructure and services established by the organisation over decades, and the potential synergies among the various programmes, were also of great relevance, in particular for the selection of the CTA-South site.

At some point ESO will be in a position to identify its next observatory-class project (in line with the ESO Vision and Strategy³), which could be a major upgrade of an existing one or a new one, either for ESO alone or in a partnership. If a new site needs to be identified and selected, technical requirements will obviously prevail and that may (or may not) require ESO to establish itself in a new place elsewhere in the world. That aside, at present the most powerful ground-based observatories that ESO has in its current programme, both in operation and under construction, are in Chile (see Barcons, 2022 for a review of ESO's programmatic views).

The evolution of Chilean astronomy

The presence of some of the most modern astronomical observatories in Chile (operated by ESO and others), specifically in the optical/infrared and millimetre/submillimetre wavelength domains, has been and remains a catalyser for the development of Chilean astronomy. University positions in astronomy have been created (in some cases supported by ESO development funds) and active

researchers, both Chilean and foreign nationals, have been recruited and have established competitive groups. Attracted by the opportunities offered by the guaranteed access to 10% of the observing time, these researchers constitute a very powerful and highly skilled task force able to exploit the observing opportunities offered by observatories at Chilean sites.

The Astronomical Society of Chile (SOCHIAS)⁴ regularly releases statistics about institutions and astronomers in the country. In their 2022 statistics⁵ they report that 23 institutions across the country are active in astronomy. In 2022 (2005) a grand total of 278 (58) professional astronomers worked in these institutions, made up of 170 (39) academic professionals plus another 108 (19) post-doctoral researchers. In addition, 256 (40) postgraduate students and more than 500 undergraduates are being trained in astronomy. The evolution of these figures in less than two decades is a clear testimony to the spectacular growth that the Chilean astronomical community has experienced.

The number of professional astronomers in Chile equates to 14.2 staff astronomers (including postdocs) per million inhabitants, which goes up to 36.3 per million when postgraduate trainees/ PhD students are added. These numbers are comparable with those for the ESO Member States, even higher in several cases.

In terms of publications in astronomy, according to the Scimago Journal and Country Rank⁶, Chile ranks 14th in the world. When normalised to the population of the country, Chile has the 7th-highest number of publications in astronomy per capita in the world. The average citations per paper is also high (36), which compares favourably with ESO Member States, where it ranges from 44 to 21.

A significant fraction of the scientific publications by the Chilean community using ESO data are shared with astronomers from ESO Member States. In fact, 25% of the total yearly publications using data obtained by ESO's telescopes are co-authored by members of the Chilean community. This is a large number when compared to the 10% of the observing time granted, which underlines the

successful collaborations between the astronomical communities of Chile and Europe.

The importance of the 10% of observing time granted to meritorious proposals by the Chilean community, as a tool to reach the current international standing, cannot be overstated. However, the actual observing time gained by the Chilean community on the VLT has exceeded 10% in about half of the periods since P80 (the record is in P109 with more than 15%). The competitiveness of Chilean proposals is well in line with that of the overall community, and therefore the observing time gained follows closely the observing time requested. Even in open competition, Chilean astronomers would normally obtain no less than 6–7% of the VLT observing time, with occasional excursions above 10%.

The emerging picture is that today there is a vibrant and productive astronomical user community in Chile and that international collaborations are significant and strong. ESO can be humbly proud of having contributed to that remarkable evolution.

Furthering the engagement between ESO and Chile

Taking note of the current astronomy landscape in the ESO Member States and in Chile, it is unavoidable to wonder about opportunities to further the existing engagement beyond the focus areas imprinted in the 1995 Agreement. That focus has been the support to the development of the astronomical community in Chile and the facilitation and support to ESO to establish its world-class observatories in the country. Success and co-evolution describe well the outcome of this joint venture.

ESO, as an intergovernmental organisation building and operating world-class research infrastructures (RIs), offers opportunities and generates impacts that go well beyond the perimeter of accessing scientific data⁷. Beyond enabling astronomical investigations through data obtained by world-class facilities, impacts in engineering through the design and development of advanced facilities, technology development, innovation and

economic impacts, education, training and engagement with society through outreach are among the benefits stimulated by the 'ESO engine' in its Member States. The extent to which such benefits materialise depends strongly on how much the countries invest in and support the development of their Research, Development, Knowledge and Innovation (RDKI) ecosystem.

The strength and stature of the Chilean astronomical community is an existing asset in the Chilean ecosystem. A natural next step to further this engagement would be the participation of Chilean groups in instrument development consortia. In Chile this is referred to as Astro-engineering and has unfortunately been limited so far.

The *National Strategy of Science, Technology, Knowledge and Innovation*⁸ presented to the President of Chile in 2022 is another important element. It acknowledges that astronomy offers opportunities for the development of the latest technologies and the provision of world-class scientific services and technologies, among other benefits. As one of the 13 challenges identified by that strategy, the *Integral exploitation of astronomy* quotes specific aspects, such as the need to engage with the supply chain of precision instrumentation, as well as others related to data management.

In December 2021 an ELT cooperation agreement was signed between ESO and ANID (the Chilean National Agency for Research and Development) to jointly fund cooperative projects of mutual interest around the ELT. Such projects would be related to smart operations, industry 4.0 tools, and other technical projects of significance to the future of ESO's observatories. They would also develop capacity building in the community around Paranal in technical areas and transfer knowledge to society. I consider this a very important step towards furthering the scope of the ESO-Chile partnership.

During a visit to CERN on 19 July 2023, the President of Chile announced the initiation of the process for Chile to become an Associate Member State of CERN⁹. The announcement acknowledges the added benefits of joining a RI like CERN,

including explicitly “*cooperation, expertise, investment and above all the growth of science and technology for the country*”. The President also confirmed the Chilean Government’s intention to triple its investment in science, therefore providing further strategic support to the country’s RDKI ecosystem.

In my view there is a path to the future with a broader scope for engagement between ESO and Chile, with Chile becoming a full ESO Member State on the horizon. A formal engagement with ESO as a full Member State by such an important partner as Chile would be indeed of the utmost importance for the organisation. As described above, there are signals that Chile may be reflecting on the added value of joining RIs, to partake in the potential opportunities they generate above and beyond user access. In the case of ESO, the context is: 1) a numerous and very competitive research

astronomical community in Chile; 2) the acknowledgement of Chile’s need to strengthen its RDKI ecosystem; 3) an existing and trusting relationship that has grown and consolidated for 60 years; and 4) ESO’s continuing openness to welcoming Chile as a full Member State, should Chile be interested in that ultimate engagement.

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References

- Barcons, X. 2022, *The Messenger*, 188, 3
Blaauw, A. 1991, ESO’s early history (Garching: European Southern Observatory)¹⁰

Links

- ¹ ESO Basic Texts: https://www.eso.org/public/archives/books/pdf/book_0017.pdf
- ² Astronomy in Chile (1849–2000): <https://www.memoriachilena.gob.cl/602/w3-article-100576.html#presentacion> (In Spanish)
- ³ The ESO Vision and Strategy: <https://www.eso.org/public/about-eso/mission-vision-values-strategy/>
- ⁴ SOCHIAS website: <https://sochias.cl>
- ⁵ SOCHIAS statistics for 2022: <https://sochias.cl/astronomia-en-chile/censos-de-astronomos/>
- ⁶ SCIMAGO Journal and Country Rank: <https://www.scimagojr.com/countryrank.php?area=3100&category=3103>
- ⁷ ESO’s Benefits to Society: https://www.eso.org/public/products/brochures/brochure_0076/
- ⁸ Chile’s National Strategy of Science, Technology, Knowledge and Innovation: <https://docs.consejoccti.cl/documento/estrategia-nacional-de-ciencia-tecnologia-conocimiento-e-innovacion-para-el-desarrollo-de-chile-2022> (in Spanish)
- ⁹ Chile and CERN (press release): <https://www.gob.cl/noticias/presidente-confirma-que-chile-esta-tramitando-su-incorporacion-como-estado-miembro-asociado-del-cern/>
- ¹⁰ ESO’s early history: https://www.eso.org/sci/libraries/historicaldocuments/ESO_Early_History_Blaauw/ESO_Early_History.pdf



This spectacular picture of the Sh2-284 nebula has been captured in great detail by the VLT Survey Telescope at ESO’s Paranal Observatory. Sh2-284 is a star formation region, and at its centre is a cluster of young stars, dubbed Dolidze 25. The radiation from this cluster is powerful enough to ionise the hydrogen gas in the nebula. It is this ionisation that produces its bright orange and red colours.